NEC
ELECTRON DEVICE

BIPOLAR ANALOG INTEGRATED CIRCUIT
μPC1237

PROTECTOR IC FOR STEREO POWER AMPLIFIER

DESCRIPTION

μPC1237 is a monolithic integrated circuit designed for protecting stereo power amplifiers and loudspeakers.

FEATURES

- Work stably within a wide power supply voltage range. (V_{CC} = 25 to 60 V)
- Contain a relay driver. (Max. I_6 = 80 mA)
- Work as either latching function or automatic resetting function by using pin 3. (In both overload detection and output offset detection, either function can be selected.)
- Need only single power supply.
- Both positive and negative output offset can be detected through the same pin. (Output offset detection through pin 2)
- AC voltage can be detected. (For AC-power-OFF mute through pin 4)
- The time delay from amplifier power ON to relay ON can be freely set by selecting external components. (For AC-power-ON mute through pin 7)
- The moment that amplifier-power is turned off, it can make relay broken OFF and then loudspeaker disconnected from amplifier to prevent a shock off noise.

ORDERING INFORMATION

PART NUMBER	PACKAGE	QUALITY GRADE
μPC1237HA	8 PIN PLASTIC SLIM SIP	Standard

Please refer to "Quality grade on NEC Semiconductor Devices" (Document number IEI-1209) published by NEC Corporation to know the specification of quality grade on the devices and its recommended applications.
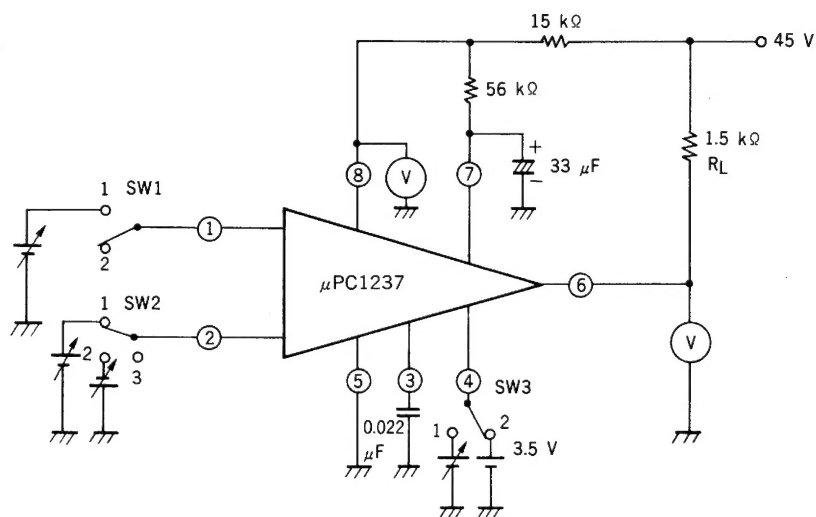
BLOCK DIAGRAM
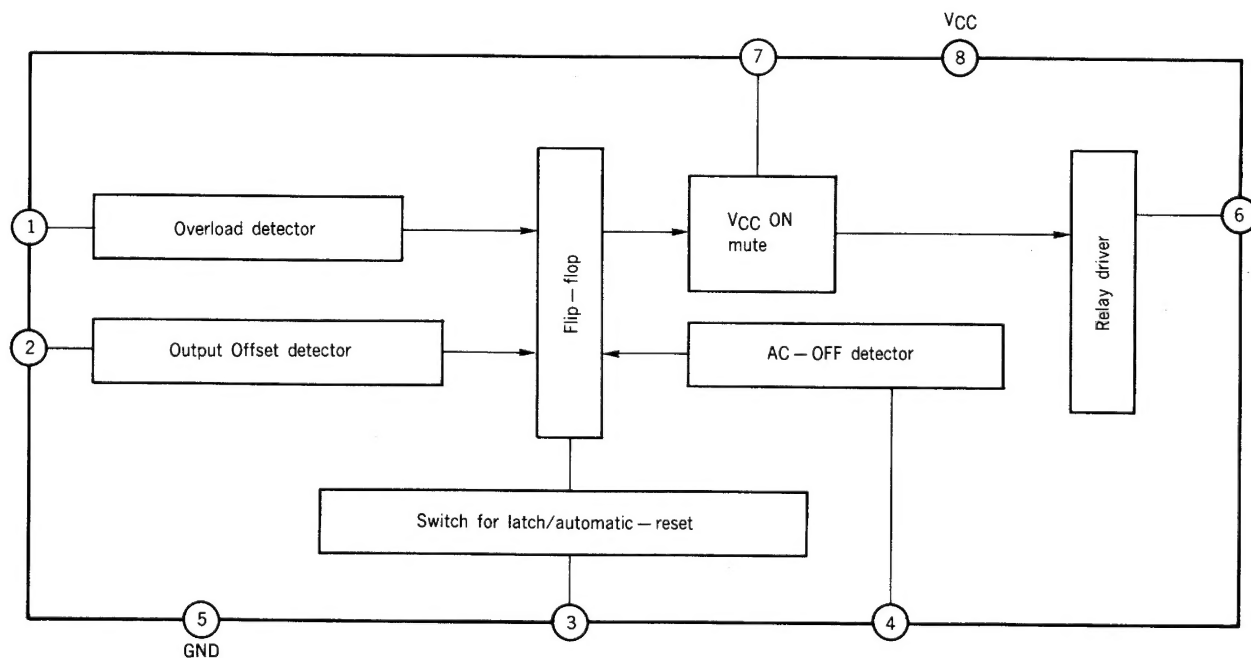
ABSOLUTE MAXIMUM RATINGS ($T_a = 25\,^\circ C$)

Power Supply Voltage	V_{CC}	60	V
Allowable Power Dissipation	P_D	320*	mW
Operational Temperature	T_{opt}	−20 to +75	$^\circ C$
Storage Temperature	T_{stg}	−40 to +125	$^\circ C$
Pin 6 Maximum Current	I_6 max	80	mA
Pin 4 Maximum Voltage	V_4 max	10	V
Pin 8 Maximum Voltage	V_8 max	8	V
Pin 1 Maximum Current	I_1 max	3	mA
Pin 2 Maximum Current	I_2 max	±3	mA
Pin 7 Maximum Voltage	V_7 max	8	V

$^*T_a = 75\,^\circ C$

RECOMMENDED OPERATING CONDITION

Supply Voltage V_{CC} = 25 to 45 to 60 V

ELECTRICAL CHARACTERISTICS (V_{cc} = 45 V, $T_a = 25\,^\circ C$, State using latching function)

CHARACTERISTIC	SYMBOL	MIN	TYP.	MAX.	UNIT	CONDITION
Pin 1 Threshold Voltage	Vth 1	0.58	0.67	0.76	V	level to invert at pin 6
Pin 2 Positive Threshold Voltage	Vth$^+$2	0.54	0.62	0.70	V	level to invert at pin 6
Pin 2 Negative Threshold Voltage	Vth$^-$2	−0.12	−0.17	−0.23	V	level to invert at pin 6
Pin 4 Threshold Voltage	Vth 4	0.60	0.74	0.90	V	level to invert at pin 6
Pin 8 Reference Voltage	V8	3.0	3.4	3.8	V	$R_L = 1.5\ k\Omega$

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TEST CIRCUIT (State using latchung function)

Switch positions

Item	SW 1	SW 2	SW 3
Vth 1	1	3	2
Vth $^+$2	2	1	2
Vth $^-$2	2	2	2
Vth 4	2	3	1
V8	2	3	2

TYPICAL APPLICATION CIRCUIT
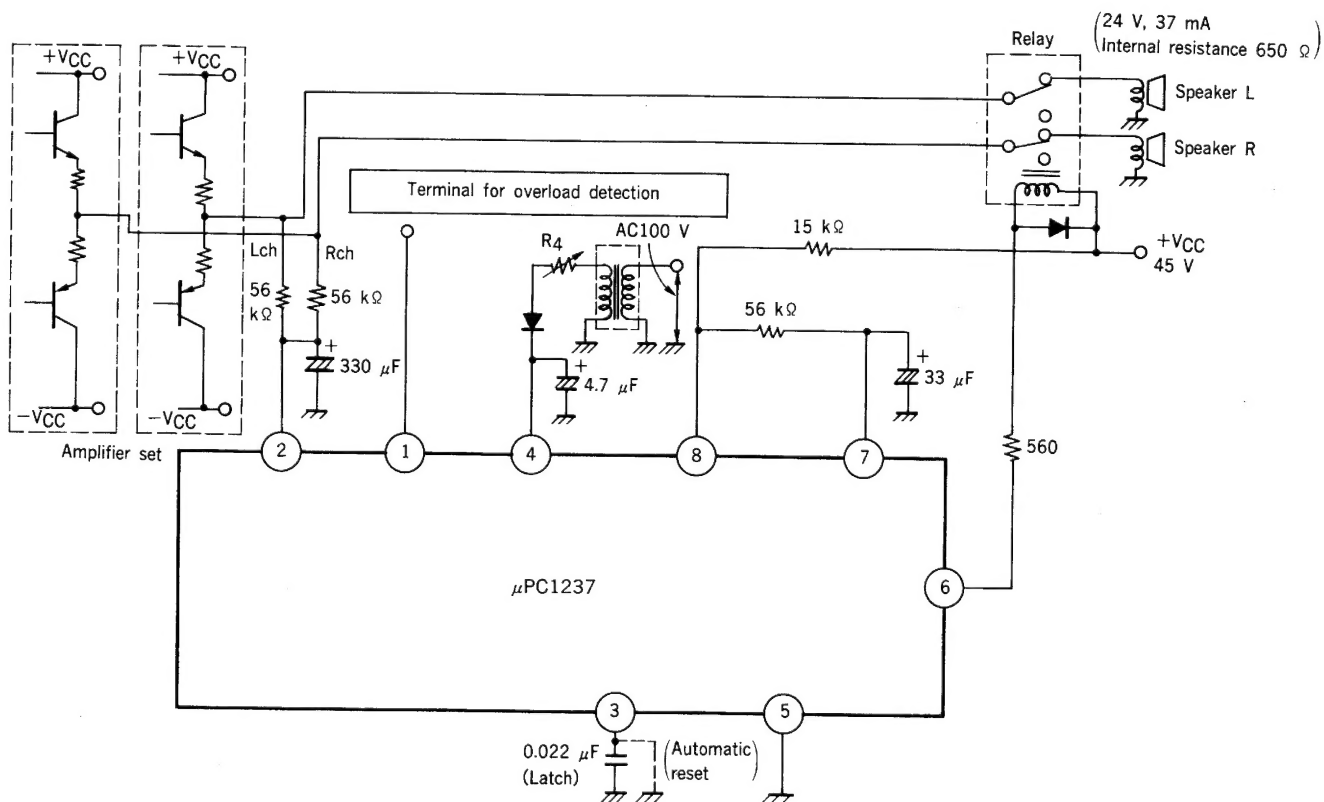
NOTE FOR USING μPC1237

1. **FUNCTION FOR OUTPUT OFFSET DETECTION (pin 2)**

    1) If too much DC current flows through a speaker voice coil due to large output offset DC level, the voice coil might be overheated and the speaker might be broken. To prevent the damage, it is necessary to detect the Output Offset DC level and to disconnect the speaker from the power amplifier by breaking off a relay if the detected DC level is shifted beyond a threshold level. μPC1237 has a function to detect both the positive and the negative Output Offset DC level with its single power supply. As shown below, you can easily make the positive and the negative threshold level equivalent and also set up their level by choosing proper resistances.

    2) How to determine the threshold levels of Output Offset detection. ($\pm$Vth)

    [1] The threshold level of positive output offset detection ($+$Vth) is given by Eq. (1).

    $$+Vth = (2 + \frac{R_A}{R_C}) \cdot Vth^+2, \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (1)$$

    where Vth^+2 is the original positive threshold level of pin 2, and $Vth^+2 = 0.62$ V TYP.

    [2] The threshold level of negative Output Offset detection ($-$Vth) is given by Eq. (2).

    $$-Vth = -\left\{ -Vth^-2 \cdot (2 + \frac{R_A}{R_C}) + I_{c2} \cdot R_A \right\}, \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (2)$$

    where Vth^-2 is the original negative threshold level of pin 2, and
      $Vth^-2 = -0.17$ V TYP.
    and I_{c2} is the current from μPC1237 and,
      $I_{c2} = 12.5 \mu$A TYP.
    at nearly $-$Vth.

    3) You can easily find how to make $\pm$Vth level equivalent as shown below

    $$(2 + \frac{R_A}{R_C}) \cdot Vth^+2 = -\left\{ -Vth^-2 \cdot (2 + \frac{R_A}{R_C}) + I_{c2} \cdot RA \right\}, \quad \dots\dots\dots\dots\dots\dots\dots\dots \quad (3)$$

    therefore determine R_A, R_B and R_C from Eq. (3)

    Attention; The original positive and negative threshold level at pin 2 without any resistances are unbalanced; $+$Vth $= 0.62$ V TYP. and $-$Vth $= -0.17$ V TYP.

    Example of design

    If you need the output offset threshold level $\pm$Vth to be $\pm$2.0 V, determine R_A, R_B and R_C as shown below.

    [1] Substitute 2.0 to $+$Vth in Eq. (1) and obtain R_A / R_C.

    $$2.0 = (2 + \frac{R_A}{R_C}) \times 0.62$$
    $$\frac{R_A}{R_C} \fallingdotseq 1.226$$

    [2] Substitute -2.0 to $-$Vth in Eq. (2) and obtain R_A (R_B) and R_C.
      $-2.0 = -0.17 (2 + 1.226) - 12.5 (\mu A) \times R_A (k\Omega)$ (V)
      $R_A = 116.1$ kΩ
      $R_C = 94.7$ kΩ
    Therefore, if you need $\pm$Vth to be 2.0 volts, choose R_A, R_B and R_C as shown below.
      $R_A = R_B = 120$ kΩ and $R_C = 91$ kΩ
    The lower limits of R_A and R_B are given by the maximum rating ($\pm$3 mA) of pin 2 and

    $$\frac{\pm V_{CC}}{R_A(B)} < \pm 3 \text{ (mA)}$$

In case of recommended condition, that is $R_A = R_B = 56$ kΩ and $R_C = \infty$, $\pm$Vth can be obtained as shown below.

    [1] $+Vth = (2 + \frac{56 \text{ (k}\Omega\text{)}}{\infty})\ \ 0.62 = 1.24$ (V)

    [2] $-Vth = -0.17 (2 + \frac{56 \text{ (k}\Omega\text{)}}{\infty}) - 12.5 (\mu A) \times 56 (k\Omega) = -1.04$ (V)
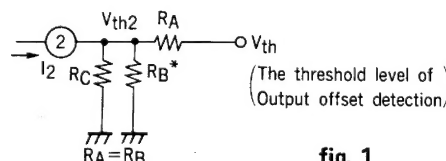
fig. 1

(The threshold level of Output offset detection)

* Rch power amplifier output terminal is usually an imaginally GND as seen from Lch power amplifier, so that the equivalent circuit can be obtained as shown above.

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2. FUNCTION OF AC LEVEL DETECTION

When you turn off the power switch, it sometimes causes a shock-off noise, therefore it is necessary to break off the relay and then to keep the power amplifier apart from loud speaker at the moment that power switch is turned off. In other words, the protection circuit is required to have a function to detect that power-off time. However, in fact, it is difficult to detect that power-off time from actual DC supply voltage line. Because it cannot be turned 0 V instantaneously due to a large capacitance inserted between the power supply line and GND. In case of μPC1237, it can detect this power-off time from AC power supply directly, that is, this is a function to detect AC level.

The AC power supply level (usually 50 Hz or 60 Hz) can be transmitted to pin 4 through a half-wave rectification circuit as shown below.

And it works within a wide range of AC level by choosing a proper resistance as R4 (Refer to the characteristic curve shown as fig.5 for the choice of R4). If power switch is turned off while the relay is being made ON and the speaker is being connected to the power amplifier output, the relay will be broken OFF to disconnect the speaker after a time delay (AC OFF mute) according to the discharge time constant determined by the voltage on pin 4, the external capacitance C4, and the internal resistance of the IC.
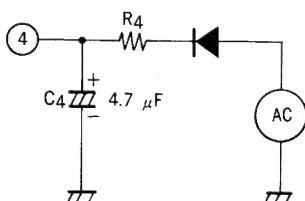

fig. 2

3. FUNCTION OF OVERLOAD DETECTION (pin 1)

The original threshold level of pin 1 is 0.67 V TYP. In case of using a constant-current drive, as the means of detection, the threshold current level is 110 μA TYP. When current which is larger than 110 μA flows to the IC, the relay will be broken OFF.

Note ; The overload detecting circuit is not included in the IC because of patent problems. Use the external circuit as an overload detection.

4. FUNCTION OF LATCHING AND AUTOMATIC RESETTING (pin 3)

If the IC detects the abnormal condition such as the larger output offset level or the overload, the IC can make the relay broken OFF. And then, two functions can be selected after the condition returns to the normal state. One is that the relay is made ON automatically and the other is that it keeps the relay broken off until once the power switch is turned off and then is turned on again.

The former is a function of automatic resetting and the latter is a function of latching. μPC1237 has both functions and can be selected either function by using pin 3. In case of latching, connect pin 3 to the ground through the capacitor, which is for preventing misoperation. For automatic resetting, connect it to the ground directly. This function is valid for both overload detection and output offset detection.

5. TIME DELAY FROM POWER AMPLIFIER POWER SWITCH ON TO RELAY ON (power-on mute at pin 7)

To suppress shock-on noise generated by power ON, a time delay is provided by connecting a circuit with a time constant. This time delay is set to make relay ON to connect speakers after enough time for the power amplifier and the preamplifier to reach a stable operating condition. The ON mute time is determined as follows,

$$T \text{ (ON mute)} = -C_7 \cdot R_7 \cdot \ln \frac{V_8 - V_7}{V_8} ,$$

where V_8 is reference voltage at pin 8, 3.40 volts, TYP. and V_7 is threshold level at pin 7, 2.06 volts, TYP.
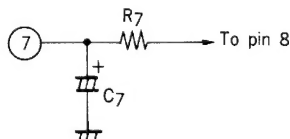

fig. 3

6. HOW TO MAKE IT WORK WITHIN A WIDE RANGE OF POWER SUPPLY VOLTAGE (pin 8)

By choosing a proper resistance R_8 connected to pin 8, the IC can work within a wide range of power supply voltage V_{CC} from 25 to 60 volts.

In case that pin 8 is directly driven by a regulated power supply, set V_8 to 3.40 volts, TYP. As for the choice of R_8 value, refer to the characteristic curve shown as fig.6.
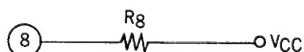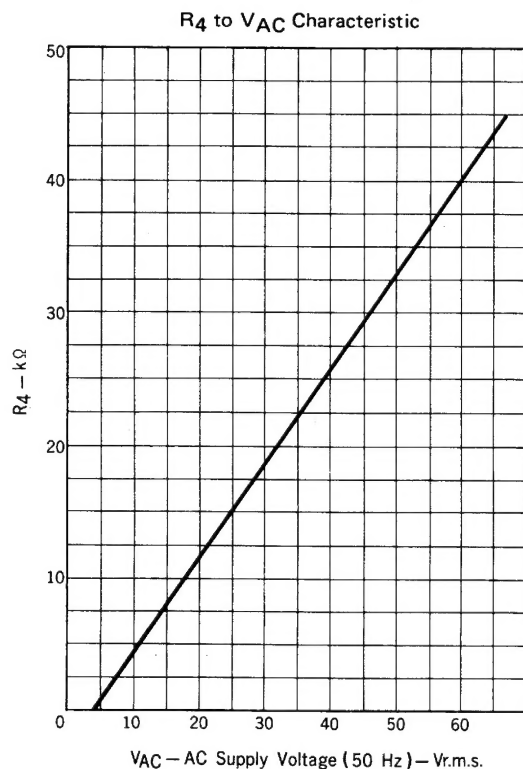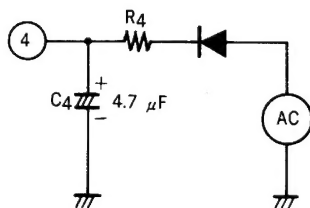

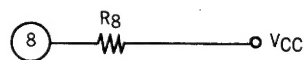**fig. 4**

fig. 5 OPTIMUM VALUE OF EXTERNAL RESISTANCE R_4

R_4 to V_{AC} Characteristic

R₄ − kΩ (vertical axis, 0 to 50)

V_{AC} − AC Supply Voltage (50 Hz) − Vr.m.s. (horizontal axis, 0 to 60)

Example) Use of E-24 series.
Select 24 kΩ R_4 for 40 volts r.m.s. V_{AC}.
If no resistance of specified value is available,
choose a resistance which is as close as possible
to and lower than the value specified by the diagram.

fig. 6 OPTIMUM VALUE OF EXTERNAL RESISTANCE R_8

R_8 to V_{CC} Characteristic

R₈ − kΩ (vertical axis, 0 to 20)

V_{CC} − Supply Voltage − V (horizontal axis, 20 to 60)
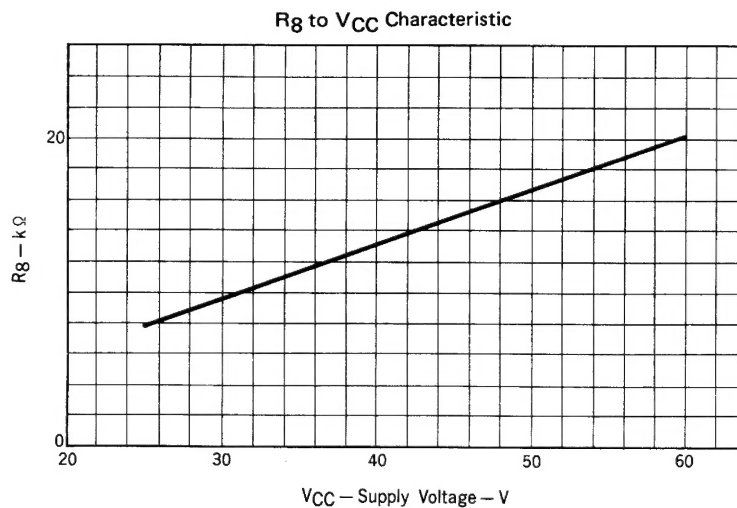
Example) Use of E-24 series.
Select 15 kΩ R_8 for 45 volts Vcc.
If no resistance of specified value is available,
choose a resistance which is as close as possible
to and lower than the value specified by the diagram.

TEMPERATURE CHARACTERISTIC

V8, T_ON mut, Vth4, Vth+2, and Vth1 to Ta Characteristics

T_a — Ambient Temperature — °C
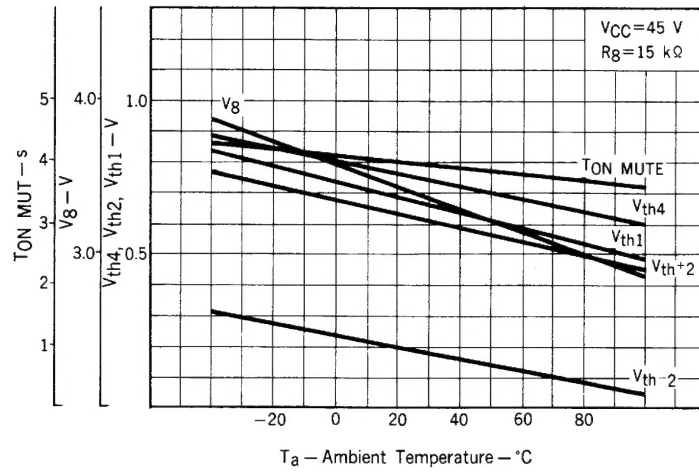
8 PIN PLASTIC SLIM SIP
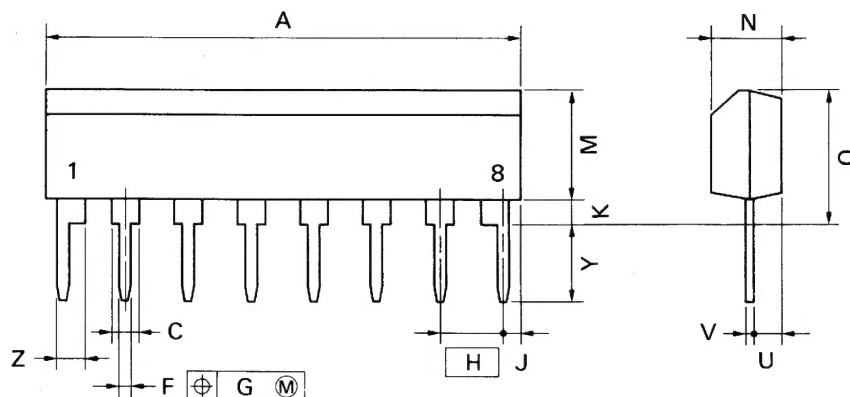
P8HA-254B

NOTE

Each lead centerline is located within 0.25 mm (0.01 inch) of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS	INCHES
A	20.32 MAX.	0.8 MAX.
C	1.1 MIN.	0.043 MIN.
F	$0.5^{\pm0.1}$	$0.02^{+0.004}_{-0.005}$
G	0.25	0.01
H	2.54	0.1
J	1.27 MAX.	0.05 MAX.
K	0.51 MIN.	0.02 MIN.
M	5.08 MAX.	0.2 MAX.
N	$2.8^{\pm0.2}$	$0.11^{+0.009}_{-0.008}$
Q	5.75 MAX.	0.227 MAX.
U	1.5 MAX.	0.059 MAX.
V	$0.25^{+0.10}_{-0.05}$	$0.01^{+0.004}_{-0.003}$
Y	$3.2^{\pm0.5}$	$0.126^{\pm0.02}$
Z	1.1 MIN.	0.043 MIN.

[MEMO]